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Transient methane emissions in the Permian Basin

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The Permian Basin is the largest and fastest growing oil and gas (O&G) producing region in the United States. Methane (CH4), a powerful greenhouse gas, is emitted from both routine and abnormal or avoidable operating conditions in the Permian Basin, including O&G production, distribution, and processing. The time scales over which these emissions persist is uncertain, and this uncertainty can lead to large discrepancies in bottom-up emission accounting. Here, we conducted an extensive airborne campaign across the majority (55,000 km^2) of the Permian Basin with imaging spectrometers to quantify individual CH4 point sources at the facility scale. We revisited each source multiple times and found that CH4 sources exhibited 26% persistence on average. Persistence-averaged CH4 emissions follow a heavy-tailed distribution, with 20% of facilities constituting 60% of the total point source budget. We quantified the total CH4 flux in the region (point + area sources) through an inverse analysis with satellite observations, and find that point sources make up 50% of the regional CH4 budget. Sector attribution of plumes shows that 50% of detected emissions result from O&G production, 38% from gathering, and 12% from processing plants. Imaging spectroscopy allows for identification of flares, and we find that 12% of CH4 plume emissions were associated with either active or inactive flares, and often emitting above 1000 kg CH4 h^{-1}, even under active flaring. These results show that regular plume-scale monitoring in heterogeneous O&G basins is necessary to understand the high intermittency of operations and resulting emissions.